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EXAMINER	

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**BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES**

Application Number: 10/823,305
Filing Date: April 13, 2006
Appellant(s): Scott Dewey

John A. Miller
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 12/12/2007 appealing from the Non Final Action mailed 08/092007.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board’s decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant’s statement of the status of amendments after the non final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

Whether claims 1-4, 6-10, 12-17, 19 and 20 should be rejected under 35 USC §103(a) as being unpatentable over U.S. Patent No. 6,762,587 issued to Barbetta (hereinafter Barbetta) in view of U.S. Patent No. 4,937,521 issued to Yoshino et al. (hereinafter Yoshino); and

Whether claims 5, 11 and 18 should be rejected under 35 USC §103(a) as being unpatentable over Barbetta in view of Yoshino, U.S. Patent No. 5,371,455 issued to Chen (hereinafter Chen) and U.S. Patent No. 3,500,372 issued to Thiele (hereinafter Thiele).

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

6,762,587	Barbetta	7/2004
4,937,521	Yoshino	6/1990
5,371,455	Chen	12/1994
3,500,372	Thiele	7/1967

(9) Grounds of Rejection

The following is the Non-Final Action mailed on 08/09/2007

DETAILED ACTION

In view of the first appeal brief filed on 12/27/2006, PROSECUTION IS HEREBY REOPENED.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-4, 6-10, 12-17, 19 and 20 are rejected under 35 U.S.C. 103(a) as being obvious over Barbetta [U.S. 6762587] in view of Yoshino et al. [U.S. 4937521].

With respect to Claim 1, Barbetta teaches a monitoring system [Fig. 1, 2, 3 fuel cell monitoring system] for monitoring the voltage potential of fuel cells in a fuel cell stack [Figs. 1, 2, 3 fuel cell stack 10, 20; col. 1 lines 12-20; col. 2 lines 36-43; col. 4 lines 6-12]; a conductor [Fig. 1, conductor 12; col. 4 lines 25-29; col. 5 lines 36-47; Fig. 2; conductive trace 21] positioned proximate to a voltage measuring means [Fig. 1, meter 13; col. 4 lines 30-35; col. 5 lines 52-63 the meter comprises attenuator 4 and amplifier 5]; a plurality of switches [Fig. 8, multiplexer 2; col. 6 lines 37-41] electrically coupled to the fuel cells and to the conductor [Fig. 7; col. 5 lines 52-63], said switches

being selectively switched on and off to separately and selectively couple each fuel cell in the fuel cell stack to the conductor and generate a current flow there through [col. 7 lines 22-32]. Barbetta teaches a differencing amplifier 5 connected to an attenuator 4 (i.e. a voltage divider, col. 6 lines 14-17) as shown in Fig. 7 and disclosed in col. 5 lines 52-64, which is connected directly to the multiplexer 2 for reading the voltages of individual cells; said differencing amplifier providing an output signal indicative of the voltage potential of the selected fuel cell [col. 5 lines 52-63]. Barbetta does not teach an intermediate stage between the fuel stack multiplexer (plurality of switches) and the differencing amplifier, comprising a Wheatstone bridge with a GMR resistor and two output ports.

Yoshino teaches a current sensor [col. 1 lines 8-12] comprising a Wheatstone bridge [Fig. 11; col. 8 lines 32-38], said Wheatstone bridge including at least one giant magnetoresistive (GMR) resistor [Fig. 11, magnetoresistor 1; col. 5 lines 7-13] and two output ports [Fig. 11, nodes 8a and B prime]; that includes sensing a magnetic field generated by the current flow through the conductor reduces the resistance of the GMR resistor and unbalances the Wheatstone bridge [col. 5 lines 37-41 and lines 52-55; col. 7 lines 4-5]; and a differencing amplifier [Fig. 11, comparator 40; col. 8 lines 38-41] electrically coupled to the output ports of the Wheatstone bridge.

Barbetta and Yoshino are analogous current measuring devices. At the time of the invention it would have been obvious to add a Wheatstone bridge with GMR type resistors to Barbetta for the benefit of accurately reading current/voltage of each cell whilst ensuring isolation existed between the cell's high voltage and the measurement

electronics, particularly since Barbetta's sensor is connected to a conductive trace [Barbetta- col. 5 lines 36-43], and Yoshino's sensor is designed to sense current flowing through a conductive trace, without touching it [Yoshino- Fig. 11; col. 3 lines 49-63]. Additionally, Wheatstone bridges with GMR type resistors used to measure current from magnetic fields are widely known in the art, and would function *exactly the same way* whether connected to a single battery, multiple batteries, or multiple fuel-cells. Further benefit gained through the use of Yoshino's GMR sensor is to overcome the difficulties associated with using coils as current measuring devices [col. 1 lines 14-40]; and additionally to follow the widespread trend of semiconductor integration of sensors, with inherent advantages, in today's electronics [col. 1 lines 54-56].

With respect to Claim 2, Barbetta teaches the switches are FET switches [col. 7 lines 37-41].

With respect to Claim 3, Yoshino teaches the at least one GMR resistor is two GMR resistors [Fig. 13, GMR resistors 1].

With respect to Claim 4, Yoshino teaches the conductor is an electrical trace positioned beneath the Wheatstone bridge [col. 1 lines 8-12; col. 3 lines 49-64; col. 5 lines 7-13].

With respect to Claim 6, Barbetta teaches least one voltage divider [Fig. 7, attenuator 4 is a voltage divider- col. 6 lines 14-17] electrically coupled between the fuel cells and the conductor.

With respect to Claim 7, Barbetta teaches a controller [Fig. 7, microprocessor 7; col. 5 lines 52-66] for controlling the switches to separately measure the voltage

potential of each fuel cell and for receiving the output signal from the amplifier [Fig. 7, amplifier 5].

With respect to Claim 8, Barbetta teaches a plurality of opto-isolators for isolating the high voltage of the fuel cell stack and the switches from the low voltage of the controller [col. 7 lines 22-32 and lines 37-41, isolation may be provided, such as with mechanical relays; col. 6 lines 34-36, opto-isolators may also be used to provide isolation].

With respect to Claim 9, Barbetta teaches the system monitors the fuel cell stack on a vehicle [col. 3 lines 12-17].

With respect to Claim 10, Barbetta teaches a monitoring system [Fig. 1, 2, 3 fuel cell monitoring system] for monitoring the voltage potential of fuel cells in a fuel cell stack [Figs. 1, 2, 3 fuel cell stack 10, 20; col. 1 lines 12-20; col. 2 lines 36-43; col. 4 lines 6-12]; *an electrical trace* [Fig. 1, conductor 12; col. 4 lines 25-29; col. 5 lines 36-47; Fig. 2; conductive trace 21] positioned proximate to a voltage measuring means [Fig. 1, meter 13; col. 4 lines 30-35; col. 5 lines 52-63 the meter comprises attenuator 4 and amplifier 5]; a plurality of *FET switches* [Fig. 8, multiplexer 2; co. 6 lines 37-41, MOSFET switches] electrically coupled to the fuel cells and to the conductor [Fig. 7; col. 5 lines 52-63], said switches being selectively switched on and off to separately and selectively couple each fuel cell in the fuel cell stack to the conductor and generate a current flow there through [col. 7 lines 22-32]; and *a controller* [Fig. 7, microprocessor 7; col. 5 lines 52-63] for controlling the switching of the FET switches to separately measure the voltage potential of each fuel cell and for receiving the output signal from

the amplifier. Barbetta teaches a differencing amplifier 5 connected to an attenuator 4 (i.e. a voltage divider, col. 6 lines 14-17) as shown in Fig. 7 and disclosed in col. 5 lines 52-64, which is connected directly to the multiplexer 2 for reading the voltages of individual cells; said differencing amplifier providing an output signal indicative of the voltage potential of the selected fuel cell [col. 5 lines 52-63]. Barbetta does not teach an intermediate stage between the fuel stack multiplexer (plurality of switches) comprising a Wheatstone bridge with a GMR resistor and two output ports.

Yoshino teaches a current sensor [col. 1 lines 8-12] comprising a Wheatstone bridge [Fig. 11; col. 8 lines 32-38], said Wheatstone bridge including at least one giant magnetoresistive (GMR) resistor [Fig. 11, magnetoresistor 1; col. 5 lines 7-13] and two output ports [Fig. 11, nodes 8a and B prime]; that includes sensing a magnetic field generated by the current flow through the conductor reduces the resistance of the GMR resistor and unbalances the Wheatstone bridge [col. 5 lines 37-41 and lines 52-55; col. 7 lines 4-5]; and a differencing amplifier [Fig. 11, comparator 40; col. 8 lines 38-41] electrically coupled to the output ports of the Wheatstone bridge.

Barbetta and Yoshino are analogous current measuring devices. At the time of the invention it would have been obvious to add a Wheatstone bridge with GMR type resistors to Barbetta for the benefit of accurately reading current/voltage of each cell whilst ensuring isolation existed between the cell's high voltage and the measurement electronics, particularly since Barbetta's sensor is connected to a conductive trace [Barbetta- col. 5 lines 36-43], and Yoshino's sensor is designed to sense current flowing through a conductive trace, without touching it [Yoshino- Fig. 11; col. 3 lines 49-

63]. Additionally, Wheatstone bridges with GMR type resistors used to measure current from magnetic fields are widely known in the art, and would function *exactly the same way* whether connected to a single battery, multiple batteries, or multiple fuel-cells. Further benefit gained through the use of Yoshino's GMR sensor is to overcome the difficulties associated with using coils as current measuring devices [col. 1 lines 14-40]; and additionally to follow the widespread trend of semiconductor integration of sensors, with inherent advantages, in today's electronics [col. 1 lines 54-56].

With respect to Claim 12, Barbetta teaches at least one voltage divider [Fig. 7, attenuator 4 is a voltage divider- col. 6 lines 14-17] electrically coupled between the fuel cells and the trace.

With respect to Claim 13, Barbetta teaches a plurality of opto-isolators for isolating the high voltage of the fuel cell stack and the FET switches from the low voltage of the controller [col. 7 lines 22-32 and lines 37-41, isolation may be provided, such as with mechanical relays; col. 6 lines 34-36, opto-isolators may also be used to provide isolation]

With respect to Claim 14, Barbetta teaches a method [Abstract, lines 1-3] for monitoring [Fig. 1, 2, 3 fuel cell monitoring system] the voltage potential of fuel cells in a fuel cell stack [Figs. 1, 2, 3 fuel cell stack 10, 20; col. 1 lines 12-20; col. 2 lines 36-43; col. 4 lines 6-12]; providing a conductor [Fig. 1, conductor 12; col. 4 lines 25-29; col. 5 lines 36-47; Fig. 2; conductive trace 21] positioned proximate to a voltage measuring means [Fig. 1, meter 13; col. 4 lines 30-35; col. 5 lines 52-63 the meter comprises attenuator 4 and amplifier 5]; selectively and separately electrically coupling the fuel

cells to the conductor to generate a current flow through the conductor [Fig. 7; col. 5 lines 52-63; col. 7 lines 22-32]; and a differencing amplifier [Fig. 7, amplifier 5] providing an output signal indicative of the voltage potential of the selected fuel cell [col. 5 lines 52-63]. Barbetta does not teach an intermediate stage between the fuel stack multiplexer (plurality of switches) and the differencing amplifier, comprising a Wheatstone bridge with a GMR resistor and two output ports.

Yoshino teaches a current sensor [col. 1 lines 8-12] comprising a Wheatstone bridge [Fig. 11; col. 8 lines 32-38], said Wheatstone bridge including at least one giant magnetoresistive (GMR) resistor [Fig. 11, magnetoresistor 1; col. 5 lines 7-13] and two output ports [Fig. 11, nodes 8a and B prime]; that includes sensing a magnetic field generated by the current flow through the conductor reduces the resistance of the GMR resistor and unbalances the Wheatstone bridge [col. 5 lines 37-41 and lines 52-55; col. 7 lines 4-5]; and a differencing amplifier [Fig. 11, comparator 40; col. 8 lines 38-41] electrically coupled to the output ports of the Wheatstone bridge.

Barbetta and Yoshino are analogous current measuring devices. At the time of the invention it would have been obvious to add a Wheatstone bridge with GMR type resistors to Barbetta for the benefit of accurately reading current/voltage of each cell whilst ensuring isolation existed between the cell's high voltage and the measurement electronics, particularly since Barbetta's sensor is connected to a conductive trace [Barbetta- col. 5 lines 36-43], and Yoshino's sensor is designed to sense current flowing through a conductive trace, without touching it [Yoshino- Fig. 11; col. 3 lines 49-63]. Additionally, Wheatstone bridges with GMR type resistors used to measure current

from magnetic fields are widely known in the art, and would function *exactly the same way* whether connected to a single battery, multiple batteries, or multiple fuel-cells. Further benefit gained through the use of Yoshino's GMR sensor is to overcome the difficulties associated with using coils as current measuring devices [col. 1 lines 14-40]; and additionally to follow the widespread trend of semiconductor integration of sensors, with inherent advantages, in today's electronics [col. 1 lines 54-56].

With respect to Claim 15, Barbetta teaches the method according to claim 14 wherein selectively and separately electrically coupling the fuel cells to the conductor includes using FET switches [Fig. 8, multiplexer 2; co. 6 lines 37-41, MOSFET switches] to selectively and separately electrically couple the fuel cells to the conductor [col. 7 lines 22-32].

With respect to Claim 16, Yoshino teaches providing a conductor positioned proximate to the Wheatstone bridge includes providing an electrical trace positioned beneath the Wheatstone bridge [col. 1 lines 8-12; col. 3 lines 49-64; col. 5 lines 7-13].

With respect to Claim 17, Yoshino teaches providing a Wheatstone bridge includes providing a Wheatstone bridge including two GMR resistors [Fig. 13, GMR resistors 1].

With respect to Claim 19, Barbetta teaches providing at least one voltage divider [Fig. 7, attenuator 4 is a voltage divider- col. 6 lines 14-17] electrically coupled between the fuel cells and the conductor.

With respect to Claim 20, Barbetta teaches the fuel cell stack is on a vehicle [col. 3 lines 12-17].

Claims 5, 11, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Barbetta [U.S. 6762587] and Yoshino et al. [U.S. 4937521] as applied to the above claims, in view of Chen [U.S. 5371455], and further in view of Thiele [U.S. 3500372].

With respect to Claims 5, 11, and 18, the combination of Barbetta and Yoshino teaches a fuel cell with a multiplexer which monitors each of the fuel cells of a fuel stack for voltage; through the use of a GMR sensor [see Claim 1 above]. The combination of Barbetta and Yoshino does not teach a polarity reverser between the fuel cell and the voltage monitor.

Chen teaches an automatic polarity reverser [Fig. 1, col. 1 lines 50-68 and col. 2 lines 1-2], said polarity reverser reversing the polarity of the current from the cells before the current is applied to the conductor so that the current through the conductor is always in the same direction.

Thiele teaches that electrochemical/fuel cells are known to experience damaging polarity reversals during internal functional faults [Col. 1 lines 12-39].

Barbetta, Yoshino, Chen, and Thiele are analogous voltage/current monitoring devices.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add an automatic polarity reversal mechanism as taught by Chen, to the combination of Barbetta and Yoshino for the benefit of preventing potentially damaging fuel cell polarity reversals [as motivated by Thiele, col. 1 lines 30-39; and Chen, col. 1 lines 27-33] from damaging the system, such as the polarity dependent differencing amplifier of the GMR sensor [Yoshino, Fig. 12, 41- positive and negative inputs must

be supplied as shown or damage can potentially occur. The current flow arrow I shown in figs. 11-13 indicate that current flow must occur in one direction only].

END OF OFFICE ACTION

(10) Response to Argument

The following is in response to the **VII. ARGUMENT** section of the appeal brief

At the outset the examiner notes that there are two issues in question:

(1) The primary issue is whether there is suggestion and/or motivation to combine Barbetta [U.S. 6762587] and Yoshino [U.S. 4937521] in order to produce a fuel cell stack that is monitored by a Wheatstone bridge giant magnetoresistive (GMR) sensor [**independent claims 1, 10, and 14**].

(2) The secondary issue is whether the combination of Barbetta, Yoshino, and Chen [U.S. 5371455], in view of Thiele [U.S. 3500372], teaches a fuel cell stack monitored by a Wheatstone bridge GMR sensor that comprises a polarity reverser [**dependent claims 5, 11, and 18**].

(1) The primary issue

The 35 USC 103(a) combination of Barbetta and Yoshino teaches *every* limitation appellant recites in independent claims 1, 10, and 14, namely a fuel cell stack that is monitored by a Wheatstone bridge GMR sensor, as set forth in the non-final action dated 08/09/2007 on pages 2-4 and 5-9, and addressed below. There is ample suggestion and/or motivation to make the combination, as set forth on pages 3-4, 6-7, and 8-9 of the action, and addressed below.

(2) The secondary issue

The 35 USC 103(a) combination of Barbetta, Yoshino, and Chen in view of Thiele teaches *every* limitation the appellant recites in dependent claims 5, 11, and 18,

namely <u>a fuel cell stack that is monitored by a Wheatstone bridge GMR sensor</u> that further comprises a <u>polarity reverser</u>, as set forth on page 10 of the action dated 08/09/2007, and addressed below. Ample suggestion and/or motivation to add Chen's polarity reverser feature (with explicit motivation to do so from Thiele) to the combination of Barbetta and Yoshino are set forth on pages10-11 of the action, and addressed below.

Arguments are addressed in the order they are presented by the appellant.

<u>(1) The primary issue</u>

The appellant argues on page 6 of the appeal that "*nowhere in Barbetta does it teach or suggest using a Wheatstone bridge including at least one giant magnetoresistive resistor that provides a voltage measurement in response to a current flowing through a conductor.*" The examiner has previously stated in the most recent non-final action sent, that the Barbetta reference by itself does *not* teach the use of the Wheatstone bridge with the at least one giant magnetoresistive resistor (GMR). As stated on page 3 lines 4-7 of the action:

> Barbetta does not teach an intermediate stage between the fuel stack multiplexer (plurality of switches) and the differencing amplifier, comprising a Wheatstone bridge with a GMR resistor and two output ports.

The examiner instead relied upon the Yoshino reference to teach the use of the Wheatstone bridge with the at least one GMR. As stated on page 3 lines 8-11 of the action:

Yoshino teaches a current sensor [col. 1 lines 8-12] comprising a Wheatstone bridge [Fig. 11; col. 8 lines 32-38], said Wheatstone bridge including at least one giant magnetoresistive (GMR) resistor [Fig. 11, magnetoresistor 1; col. 5 lines 7-13] and two output ports [Fig. 11, nodes 8a and B prime];

At the bottom of page 6, <u>appellant acknowledges that Yoshino discloses the use of a Wheatstone bridge with GMR sensor</u>, but then argues on page 7 that: "*However, Appellant submits that nowhere in Yoshino does it teach or suggest using the current detecting circuit to measure the voltage of fuel cells in a fuel cell stack*."

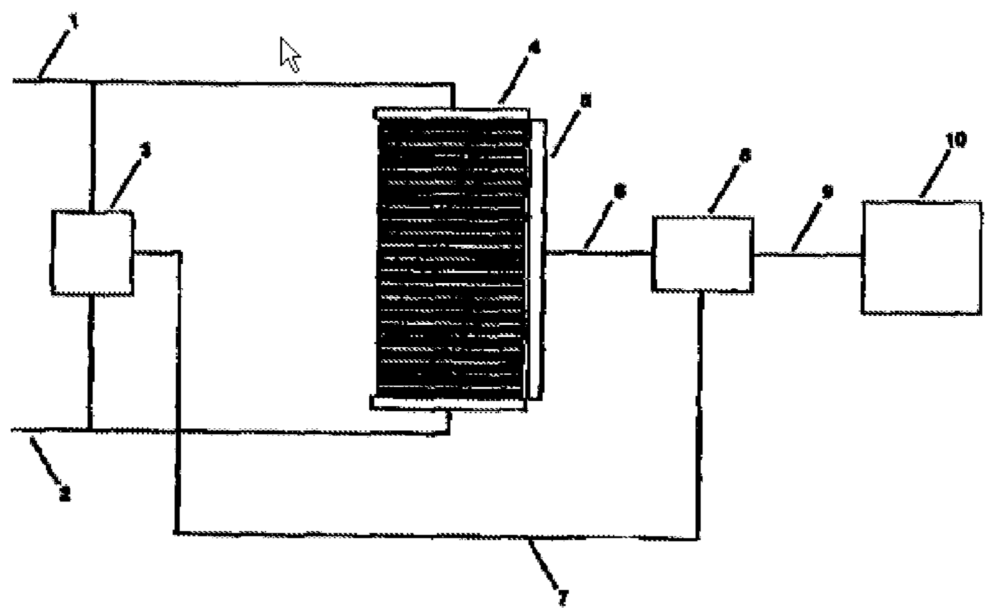
As stated by the examiner, Barbetta is used to provide this teaching. Page 2 lines 7-10 of the action state:

With respect to <u>Claim 1</u>, Barbetta teaches a monitoring system [Fig. 1, 2, 3 fuel cell monitoring system] for monitoring the voltage potential of fuel cells in a fuel cell stack [Figs. 1, 2, 3 fuel cell stack 10, 20; col. 1 lines 12-20; col. 2 lines 36-43; col. 4 lines 6-12];

As shown above, the examiner has clearly relied upon the *combination* of Barbetta and Yoshino to teach the limitations of claim 1, namely <u>the fuel cell stack [as taught by Barbetta] is coupled with and monitored by a Wheatstone bridge GMR sensor [as taught by Yoshino]</u>; and not on either of the references alone. **Therefore arguments attacking each of the references individually represent "piecemeal" type analysis and are subsequently not well-founded.**

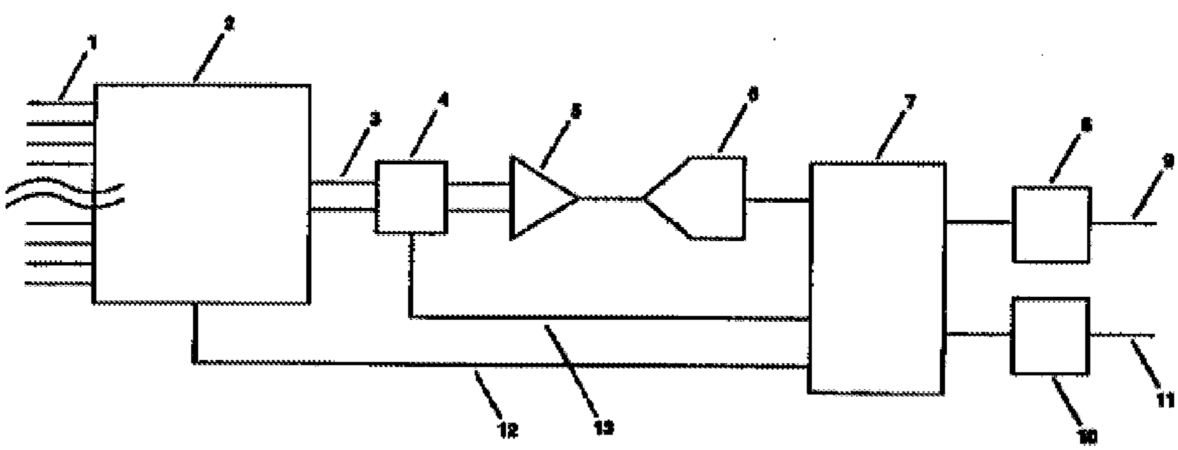
The reproduced drawing below illustrates the combination between Barbetta and Yoshino:

Figure 3



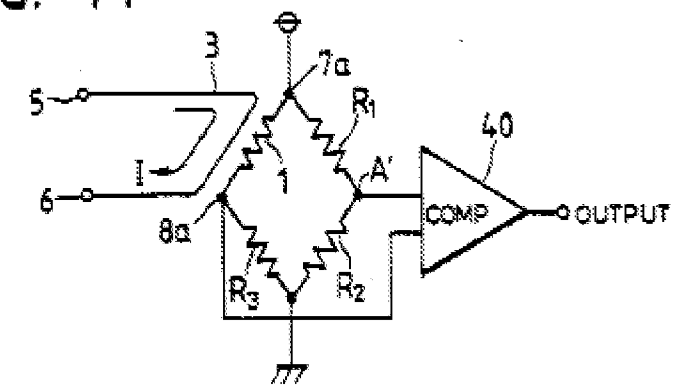
Barbetta's Fig. 3 reproduced, showing fuel cell stack 4 monitored by meter 8.

Figure 7



Barbetta's Fig. 7 reproduced, showing current input from fuel cell stack 4 along lines 1, through multiplexer switches 2, and monitored by meter 8 [which is shown here as voltage divider 4, comparator 5, and decoder 6]. These submit a signal to microprocessor 7 which determines the strength of the signal along lines 1.

FIG. 11



Yoshino's Fig. 11 reproduced, showing a Wheatstone bridge with GMR sensors R1 and R3, fed by current from conductor 3. The output at comparator 40 indicates the strength of the current I flowing.

In combining Barbetta and Yoshino, one of ordinary skill essentially replaces Barbetta's monitoring meter 8 with Yoshino's Wheatstone bridge circuit shown above. There is no contention on the part of the appellant that this combination does not result in the claimed invention.

On pages 7-8 appellant acknowledges that the combination of Barbetta and Yoshino teaches the claimed invention, but argues that the combination "*is not relevant because Yoshino does not teach or suggest that its current detecting device can be used in such a manner* (i.e. be combinable with a fuel cell)". Appellant also argues on page 7 that "*there is no teaching, suggestion or motivation in either Barbetta or Yoshino, or in the knowledge generally available to one of ordinary skill in the art, to use a wheatstone bridge having a magnetoresistive resistor for measuring the current flow*

through a conductor electrically coupled to a fuel cell so as to measure the voltage of the fuel cell."

The examiner completely disagrees with this assessment. **There is ample suggestion and motivation to make the combination between Barbetta and Yoshino to create a <u>fuel cell stack [as taught by Barbetta] that is monitored by a Wheatstone bridge GMR sensor [as taught by Yoshino]</u>.** Pages 3-4 of the action set forth the motivation as to why one of ordinary skill in the art would make the combination between Barbetta and Yoshino in order to arrive at the claimed <u>fuel cell stack that is monitored by a Wheatstone bridge GMR sensor</u>, reproduced below:

> Barbetta and Yoshino are analogous current measuring devices. At the time of the invention it would have been obvious to add a Wheatstone bridge with GMR type resistors to Barbetta for the benefit of accurately reading current/voltage of each cell whilst ensuring isolation existed between the cell's high voltage and the measurement electronics, particularly since Barbetta's sensor is connected to a conductive trace [Barbetta- col. 5 lines 36-43], and Yoshino's sensor is designed to sense current flowing through a conductive trace, without touching it [Yoshino- Fig. 11; col. 3 lines 49-63]. Additionally, Wheatstone bridges with GMR type resistors used to measure current from magnetic fields are widely known in the art, and would function *exactly the same way* whether connected to a single battery, multiple batteries, or multiple fuel-cells. Further benefit gained through the use of Yoshino's GMR sensor is to overcome the difficulties associated with using coils as current measuring devices [col. 1 lines 14-40]; and additionally to follow the widespread trend of semiconductor integration of sensors, with inherent advantages, in today's electronics [col. 1 lines 54-56].

First reasoned statement

Second reasoned statement

Third reasoned statement

There are **three reasoned statements** in the portion of the reproduced action above which illustrate why one of ordinary skill would make the combination. These reasoned statements clearly establish motivation to combine and stand on their own merits.

Appellant addresses the **first reasoned statement** on page 8 of the appeal by stating that "*The Examiner states on page 3 of the Office Action that "Barbetta and Yoshino et al. are analogous current measuring devices," and "[a]t the time of the invention it would have been obvious to add a Wheatstone bridge with GMR type resistors to Barbetta <u>for the benefit of accurately reading current/voltage of each cell while ensuring isolation existed between the cells high voltage and the measurement electronics</u>... ". However, what Appellant submits that the Examiner has failed to do is explain why one of ordinary skill in the art would combine the current detecting device of Yoshino et al. into the fuel cell voltage detecting device of Barbetta, and therefore has used improper hindsight.*" **The examiner submits the underlined portion directly above, taken from the action and repeated by the appellant, clearly and effectively answers the question of <u>why.</u>**

Appellant continues to state on page 8 of the appeal that in the final office action [dated 11/08/2006], "*the examiner cited MPEP 2143.01 in order to use the knowledge generally available to one of ordinary skill in the art to satisfy the motivation to combine Yoshino and Barbetta. <u>Thus, it is the Examiner's position that neither Yoshino nor Barbetta independently or together provide the motivation to combine their teachings.</u>*"

This statement is not entirely correct, because appellant ignores some of the statements that are part of the motivation to combine [the **first, second and third reasoned statements** to combine, given above]. Appellant argues on page 9 that points (1)-(8) given by the examiner in the *Response to Arguments* section of the final action dated 11/08/2006, were constructed out of hindsight, and that since it required an eight step process to arrive at a conclusion of obviousness, that it is unlikely on its face that the process is *prima facie* obviousness. Appellant's statement that hindsight was used to construct the original motivation is not well founded, because the examiner has laid out in detail [per points (1)-(8)] <u>why</u> one of ordinary skill would make the combination, and further, **the Appellant has no real response as to why the 8 points originally offered does not constitute proper motivation**, other than to say it is essentially <u>too long</u>. The examiner also notes that the <u>abbreviated version</u> of points (1)-(8) presented on page 9 of the appeal lacks the full persuasive impact of establishing motivation to combine, as compared to the original points (1)-(8) set forth by the examiner. Therefore, **the examiner's points (1)-(8) are reproduced below** [taken from the *Response to Arguments* section of the final action dated 11/08/2006]:

The examiner also notes the following:

(1) Fuel cells are known to produce high voltages, either singularly or when combined into a stack as shown in Barbetta [Fig. 1, stack 10]. A stack can even be used as a power generation platform- [col. 1 lines 39-42]. This suggests to the examiner that a means of monitoring the quality of power produced i.e. the voltage; is necessary, since it is well known that loads require a stable source of power. This answers the question of why combine a fuel cell with a voltage/power monitor- the reason is to ensure quality power output to prevent damage to the load.

(2) The modern means of interpreting the monitored voltage/power [whether from a fuel cell, battery, or other means] is typically microprocessor or computer based- [col. 5 lines 63-66].

(3) It is well known that microprocessors/computers are low voltage based circuitry, which require isolation from the power supply for safety to equipment and users.

(4) This begs the question of the skilled artisan, how best to monitor the fuel cell voltage whilst ensuring isolation between the sensor/processor and the fuel cells?

(5) At this point the skilled artisan would look to the most common means of sensing, such as current sensing resistors, and toroid/current transformers, for example.

(6) The examiner believes that the skilled artisan would rule out current sensing resistors, because they offer no isolation and waste power through heat dissipation. Current transformers are explicitly ruled out in [col. 1 lines 14-40] because they are inaccurate and expensive, among other reasons.

(7) Based on 1-6, the examiner believes that the skilled artisan, faced with the references by Barbetta and Yoshino and the question outlined in (4), would look to the GMR as a means of sensing the voltage of the fuel cells as a means of accurately measuring the voltage of the fuel cells- [Yoshino, col. 5 lines 28-33]. With respect to the issue of isolation, [col. 5 lines 36-63] outlines the theory of operation of the GMR, which makes it clear that magnetic isolation is provided for between the fuel cell output conductor and the active sensing material of the GMR. This answers the question of why specifically use a GMR as the voltage monitoring means to sense voltage and provide isolation from the power supply- the answer is to provide increased sensor accuracy and power supply isolation.

(8) Additionally, it is noted that Yoshino teaches integrating the GMR sensor into a semiconductor integrated circuit- [col. 1 lines 54-56]; whilst Barbetta's fuel cell stack outputs power through conductors that can be on flexible circuit boards- [col. 4 lines 24-30] or conductive traces- [col. 5 lines 44-47]. This serves as an additional motivation/suggestion to combine Barbetta's fuel cell output with Yoshino's GMR monitoring means.

Each of points (1)-(8) above clearly establish motivation as to why one of ordinary skill in the art would combine Barbetta's fuel cell stack with Yoshino's Wheatstone bridge GMR sensor to produce appellant's claimed invention, and each point stands on its own merits.

Appellant's response to the above examiner points (1)-(8) consists of stating, firstly that the motivation is *too long* [page 9 of the appeal], and secondly that if using the GMR sensor to monitor fuel cells were in fact true, then "*skilled artisans other than*

the examiner would have previously used this technique for measuring the voltage of fuel cells in a fuel cell stack…" [page 10 of the appeal].

With respect to the first argument, the length of the motivation is not an indication that hindsight was used, it is merely an attempt to explain [in explicit detail and with simplicity] to the appellant the type of reasoning one of ordinary skill would take when presented with the Barbetta and Yoshino references on hand, and attempting to solve the problem of how to best monitor a fuel cell. Appellant will recall that the "lengthy" points (1)-(8) were presented in the *Response to Arguments* section in an attempt to explain the much shorter **first and second reasoned statements** originally offered as motivation, which the appellant rejected as lacking. The (1)-(8) examiner points taken as a whole is NOT a single explanation covering only one motivation [and therefore an attempt to stretch or over-reach as the appellant seems to be implying]. It is a logical, step-by-step explanation that covers EIGHT distinct [but related] steps, in which EACH step suggests its own desirability for combining.

Step 1 outlines that fuel cells are known to be used in power generation platforms. Loads connected to power generation platforms require a stable supply of energy. This is an indication that the power output to the load MUST be monitored. [Barbetta provides monitoring via the meter 7 shown in Fig. 3, and detailed in Fig. 7 as comprising an attenuator 4, amplifier 5, converter 6, and microprocessor 7]. **Appellant has failed to effectively counter this statement,** because it is correct.

Step 2 outlines that when voltage or current is monitored, it is typically performed by a microprocessor. This is standard in the art today. Such is also disclosed by

Barbetta's Fig. 7, which shows microprocessor 7 interpreting the output of items 4, 5, and 6]. **Appellant has failed to effectively counter this statement,** because it is correct.

Step 3 outlines that microprocessors are LOW VOLTAGE based circuitry, and therefore require ISOLATION from power supplies [such as fuel cell stacks]. Items 4, 5, and 6 in Barbetta's Fig. 7 affords some amount of isolation between the fuel cell stack 4 [Fig. 3] and the microprocessor 7 [Fig. 7]. **Appellant has failed to effectively counter this statement,** because it is correct.

Step 4 presents the hypothetical question- how would one of ordinary skill in the art best monitor a fuel cell whilst ensuring isolation between the fuel cell stack and the microprocessor?

Step 5 outlines that one of ordinary skill would first look to the most common means of sensing, such as current resistors, and current transformers with coils [conventionally known, per Yoshino- col. 1 lines14-26].

Step 6 outlines why the skilled artisan would eliminate the means known in step 5- because resistors result in wasted heat, and current transformers are inaccurate/expensive [Yoshino, col. 1 lines 27-40]. **Appellant has failed to effectively counter this statement,** because it is correct.

Step 7 outlines exactly why the skilled artisan would choose Yoshino's Wheatstone bridge GMR sensor for monitoring the output of Barbetta's fuel cell stack- because of increased accuracy over conventional methods [explicitly stated by Yoshino in col. 1 lines 44-46, and 52-53]. Step 7 further motivates the issue of isolation-

Yoshino's GMR sensor is *designed* to provide for isolation- as explicitly shown in col. 1 lines 64-68 and col. 2 lines 1-4; col. 3 lines 58-61. Step 7 explicitly shows from the references themselves why one would make the combination- for accuracy of detection, and to provide for isolation. **Appellant has failed to effectively counter this statement,** because it is correct.

Step 8 adds an additional suggestion to combine- that Yoshino teaches integrating the GMR sensor into a semiconductor integrated circuit- [col. 1 lines 54-56]; whilst Barbetta's fuel cell stack outputs power through conductors that can be on flexible circuit boards- [col. 4 lines 24-30] or conductive traces- [col. 5 lines 44-47]. This serves as an additional motivation/suggestion to combine Barbetta's fuel cell output with Yoshino's GMR monitoring means. **Appellant has failed to effectively counter this statement,** because it is correct.

With respect to the second argument, appellant is essentially suggesting that since the examiner could not find a single reference showing the fuel cell stack measured by a GMR sensor, that this somehow negates the desirability to combine two separate references to arrive at the very same fuel cell stack measured by a GMR sensor. Such reasoning is flawed at face value, and is incorrect for two reasons- firstly, the desirability to combine has been clearly laid out in the **first, second, and third reasoned statements** [as set forth on pages 3-4 of the non-final action dated 08/09/2007, and reproduced above]. To assert that such desirability to combine is negated simply because the examiner could not find a 35 USC 102 type reference is to *ignore the very purpose of the 35 USC 103 type combination*- that being to reject

applications that are merely an integration of two or more existing inventions which are obvious to combine. Secondly, such an assertion ignores the real-world time-limited conditions under which examiners work. Sometimes, it is simply not possible to locate a single reference containing all of the recited limitations in the allotted amount of time. **The lack of a 102 type reference does not and cannot negate the desirability to combine as given in the first, second, and third reasoned statements; as well as points (1)-(8) presented above.**

As is clearly seen, the examiner has established a reasoned rationale and motivation as to why one of ordinary skill would combine the **<u>fuel cell stack [as taught by Barbetta] with a Wheatstone bridge GMR sensor [as taught by Yoshino]</u>**. Appellant's *only response* to these points [on pages 8-10 of the appeal] is to claim that the motivation is <u>too long</u>, or somehow indicative of <u>hindsight because it is not illustrated in a single reference</u>. These two responses fail to overcome the eight reasoned statements as addressed above.

<u>(2) The secondary issue</u>

Appellant argues on page 10 that "*Barbetta does not teach a polarity reverser because Barbetta is not using the propagation of current through a conductor as part of the device.*" **This statement is not entirely correct.** Barbetta discloses a cell to cell contact assembly 5, Fig. 3, which is a conglomeration of switches formed as a multiplexer, as shown in Fig. 8. Barbetta does have the <u>hardware</u> necessary to accomplish polarity reversal of the voltage leaving fuel cell stack 10, Fig. 1, and entering meter 7, Fig. 3. However, Barbetta does not disclose that those switches are

functionally switched to accomplish polarity reversal [i.e. the fuel cell controller lacks the *programming* to accomplish such]. Instead, the multiplexer switches are switched to select one fuel cell at a time for monitoring. Chen is relied upon to provide the feature of automatic polarity detection and reversal. Further, **Barbetta does in fact disclose propagation of current through a conductor**; such is explicitly stated in the abstract, reproduced below:

> A device and method to measure individual or grouped cell voltages to monitor fuel cell performance for diagnostic or control purposes. More particularly, the present invention involves a device to make attachments to individual cells or groups of cells of a fuel cell stack which measures the voltage or the differences of voltages at a plurality of points of these individual cells or groups of cells, the relationship of these voltages to other fuel cell stack operating parameters, or the fuel cell stack current relationship, tran-

Appellant argues on page 10 that "*the current detecting device in Yoshino would not need a polarity reverser because there is no indication in Yoshino that the current detected by the device could be propagating through the conductor in opposite directions.*" That the current could be propagating in an opposite direction is suggested by Thiele, in col. 1 lines 30-34 [**reproduced below**], which explicitly state that fuel cells can undergo dangerous *polarity reversals* – i.e. the current can flow in the opposite direction in a fuel cell if the polarity is reversed.

> **One of the significant problems in operating electrochemical batteries such as fuel cell batteries in typical load applications is that individual cells occasionally drop excessively in voltage or even reverse in polarity because of internal functional faults. Since such reversal**

Additionally, Yoshino clearly shows that it is mandatory that the current flow in one direction ONLY, per Figs. 11, 12, and 13. Current arrow I in conductor 3 is indicated as

flowing in ONE direction only in all three embodiments. This is because the comparators 40-42 are polarity dependent electronic devices, as indicated by their + and - terminals. Reversing the flow of current through conductor 3 will result in either damage to the comparators, or garbled/no output at the comparator output. Yoshino clearly shows that current must flow in one direction only. This is the driving motivation which shows it would be desirable to add polarity reversal protection to the *combination* of Barbetta and Yoshino. **In attacking the Yoshino reference alone instead of the *combination* of Barbetta and Yoshino, appellant is again improperly using "piecemeal" type analysis.**

Appellant argues on page 11 that he is "*unsure what cells or what conductor the examiner is referring to because Chen does not talk about cells or a conductor*." This is incorrect. In fact, **ALL four references used explicitly shows "cells" and "conductors".** The cells are the fuel cells illustrated in Barbetta [Fig. 3, fuel cell stack 4, and the conductor is lines 6 and 7, also shown in Fig. 3]. **In Chen, the equivalent cell would be battery 2, [Fig. 1] and the conductor would be the conductors connecting battery 2 to reverse polarity detecting circuit 8.** In Yoshino, the equivalent cell would be whatever cell is connected to be sensed at terminals 5, 6 of the GMR sensor in Figs. 11, 12, and 13; and the equivalent conductor would be current conductor 3 carrying the requisite current to be sensed. In Thiele, the cells are fuel cell battery 10, [Fig. 1] and the conductors are shown as conductors A and B.

Appellant argues on page 11 "*that Chen does not teach or suggest a polarity reverser in a monitoring circuit for monitoring the voltage across fuel cells in the fuel cell*

stack where the polarity reverser reverses the voltage polarity from fuel cells so that the current sent to the conductor positioned in close proximity to a wheatstone bridge always flows in the same direction." Once again, the appellant is using a "piecemeal" type approach in an attempt to disqualify Chen. The non final action dated 08/09/2007 clearly states that it is the *combination of Barbetta, Yoshino, and Chen, as motivated by Thiele*, that produces and motivates the combination which results in a **fuel cell stack [as taught by Barbetta] that is monitored by a Wheatstone bridge GMR sensor [as taught by Yoshino]; the combination being protected by an automatic polarity reversal feature [as taught by Chen], with motivation to add the automatic polarity detection and reversal feature to the combination of Barbetta and Yoshino [given in Thiele].** Page 10 of the action showing this combination is reproduced below:

Claims 5, 11, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Barbetta [U.S. 6762587] and Yoshino et al. [U.S. 4937521] as applied to the above claims, in view of Chen [U.S. 5371455], and further in view of Thiele [U.S. 3500372].

With respect to Claims 5, 11, and 18, the combination of Barbetta and Yoshino teaches a fuel cell with a multiplexer which monitors each of the fuel cells of a fuel stack for voltage; through the use of a GMR sensor [see Claim 1 above]. The combination of Barbetta and Yoshino does not teach a polarity reverser between the fuel cell and the voltage monitor.

Chen teaches an automatic polarity reverser [Fig. 1, col. 1 lines 50-68 and col. 2 lines 1-2], said polarity reverser reversing the polarity of the current from the cells before the current is applied to the conductor so that the current through the conductor is always in the same direction.

Thiele teaches that electrochemical/fuel cells are known to experience damaging polarity reversals during internal functional faults [Col. 1 lines 12-39].

Barbetta, Yoshino, Chen, and Thiele are analogous voltage/current monitoring devices.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add an automatic polarity reversal mechanism as taught by Chen, to the combination of Barbetta and Yoshino for the benefit of preventing potentially damaging fuel cell polarity reversals [as motivated by Thiele, col. 1 lines 30-39; and Chen, col. 1 lines 27-33] from damaging the system, such as the polarity dependent differencing amplifier of the GMR sensor [Yoshino, Fig. 12, 41- positive and negative inputs must be supplied as shown or damage can potentially occur. The current flow arrow I shown in figs. 11-13 indicate that current flow must occur in one direction only].

Therefore appellant's argument with respect to Chen <u>alone</u> not teaching the combination is not well founded.

Appellant's final argument on page 12 state that "*identifying the well known technique of polarity reversal of a fuel cell in a fuel cell stack is very different than employing a polarity reverser in a fuel cell voltage monitoring system where the polarity reverser switches the polarity of every other fuel cell so that the current applied to a*

conductor adjacent a wheatstone bridge always flows in the same direction." While this point is not necessarily disagreed with by the examiner, it is non-the-less unconvincing because a polarity reverser was recited by appellant, and a polarity reverser was supplied by Chen, with proper motivation to combine by Thiele. That the polarity reverser is <u>not the same kind, or does not operate the same way</u>, is irrelevant in view of what is actually claimed in claims 5, 11, and 18; which merely claims *a polarity reverser that reverses the polarity of current from a fuel cell through the conductor so that current flow is always in one direction*. All of this is accomplished by the combination, as shown above. **Therefore the argument that Chen supplies a different polarity reverser is unpersuasive**, in view of what is claimed.

<u>Summary</u>

The **<u>(1) The primary issue</u>** stated at the outset has been met. The 35 USC 103(a) combination of Barbetta and Yoshino teaches *every* limitation appellant recites in independent claims 1, 10, and 14, namely <u>a fuel cell stack that is monitored by a Wheatstone bridge GMR sensor.</u> The requirement for a reasoned motivation to combine Barbetta and Yoshino has been met as expressed above.

<u>(2) The secondary issue</u> stated at the outset has been met. The 35 USC 103(a) combination of Barbetta, Yoshino, and Chen in view of Thiele teaches *every* limitation the appellant recites in dependent claims 5, 11, and 18, namely <u>a fuel cell stack that is monitored by a Wheatstone bridge GMR sensor</u> that further comprises a <u>polarity reverser feature.</u> The requirement for a reasoned motivation to combine Barbetta, Yoshino, Chen, and Thiele has been met as expressed above.

The examiner adds 2 final notes: (1) Appellant's case laws cited throughout the action appear outdated; and appellant has failed to address the most recent case law applicable here, that being *KSR vs. Teleflex*. A reasoned rationale has been presented and substantiated by the examiner in order to make the combination of the known fuel cell with the known GMR sensor, and express teachings in the references themselves are *not* required to make the combination [even though there is ample suggestion in each reference to do so, as shown above]. The combination clearly does not result in anything that is *unpredictable* in the art; it merely results in a fuel cell monitored by a specific type of current sensor. (2) The level of skill in the art required to make the combination between a fuel cell stack, currently monitored by one type of sensor [as taught by Barbetta], with a GMR sensor, which is simply another kind of sensor designed to monitor current [as taught by Yoshino], is trivial.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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